



Sustainable Agriculture with biofertilizers and organic fertilizers by smallholder farmers in Thailand

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Outline of the presentation

1.Introduction

2.Biotechnology (organic fertilizers and biofertilizers)

3.LDD microbial products

4.Transfer technology

5.Extension on biotechnology to substitute chemical agriculture substances

6.Vetiver grass

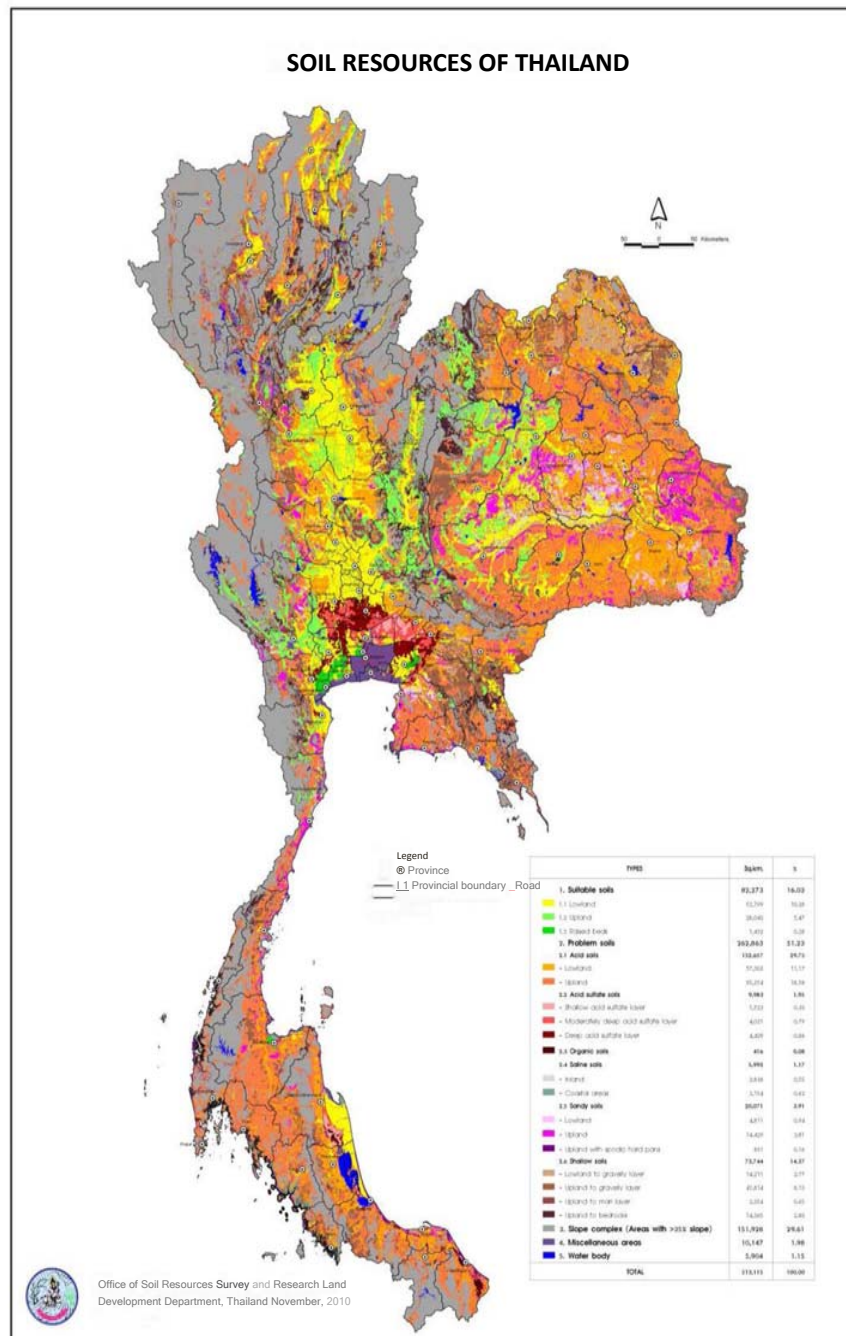
Soil Resources of Thailand

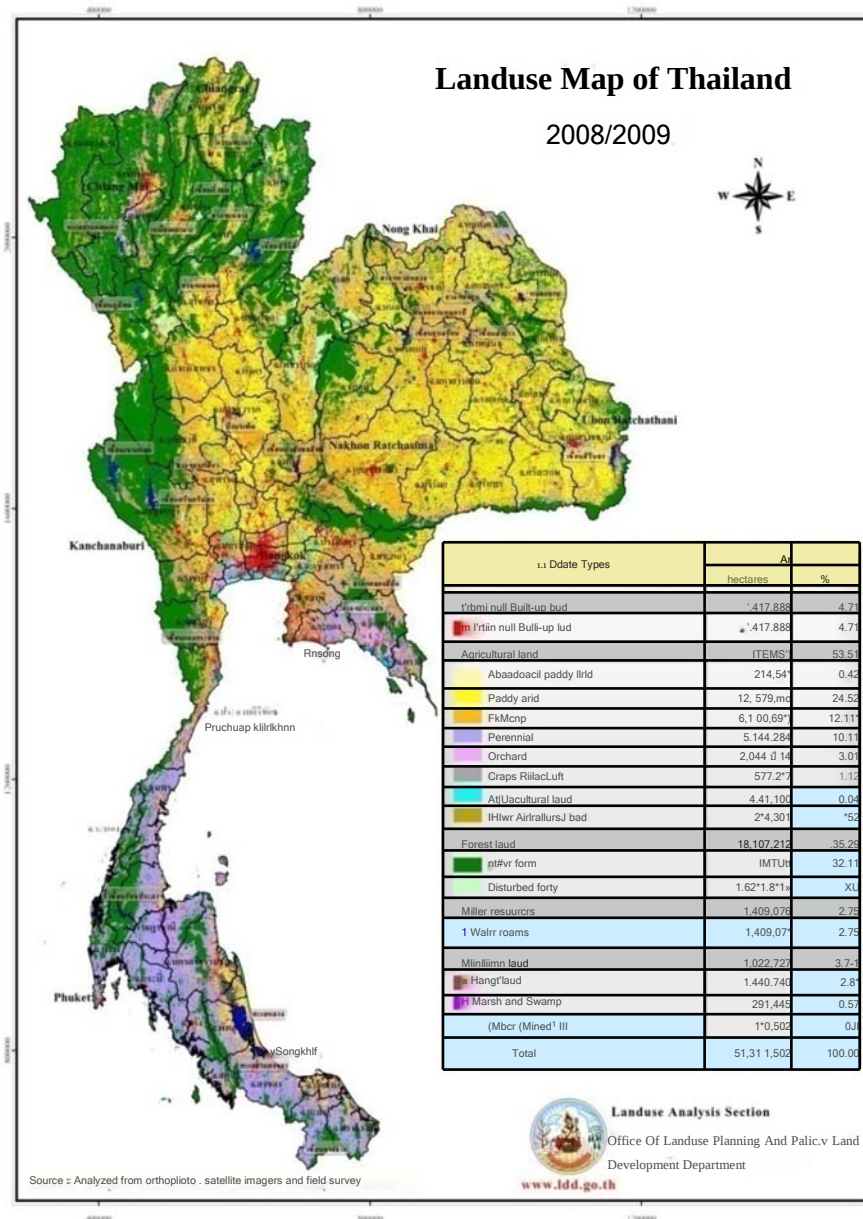
Thailand covering total area 51.31 m.ha

agricultural area 46.5 %

not agricultural area 20.1 %

forest area 33.4 %





Land Use of Thailand

Agricultural area 22.2 million ha

□ Paddy Field 11.28 million ha

■ Field Crop 5.02 million ha

- Cassava 1.70 million ha
- Sugarcane 1.67 million ha
- Maize 1.65 million ha

□ Perennial Crop 4.42 million ha

Para Rubber 3.31 million ha Oil
Palm 0.60 million ha Eucalyptus
0.51 million ha

□ Orchard 1.54 million ha

- Mixed Fruit 1.16 million ha
- Coconut 0.19 million ha
- Longan 0.19 million ha



Conventional agriculture production in Thailand
need more application of chemical fertilizer to
accelerate plant's growth including utilization
herbicides, insecticides and fungicide for eradicating
weed, pests and disease.

Problem of chemical agriculture

Directly affect the health of farmers and consumers

Cause the contamination in agricultural products
and environment

Adverse impact to the soil properties



Hardening and crusting
of soils

Soil aggregate by organic
matter and root

How to encourage using organic fertilizers/biofertilizers

- **Measurement of biomass utilization** : agricultural waste, agro-industrial waste, animal manure, could be used as organic fert. for soil improvement
- **Giving knowledge management to farmers**

Incorporated plant stubble



Making compost



Making bio extract

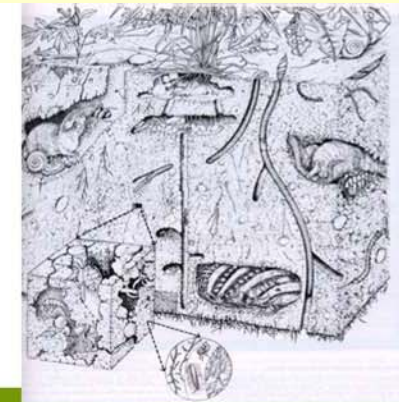
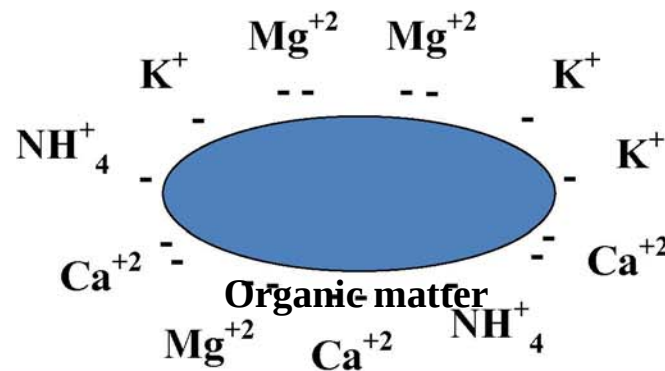
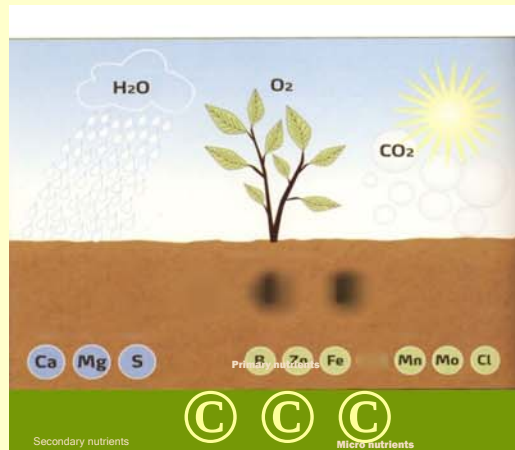
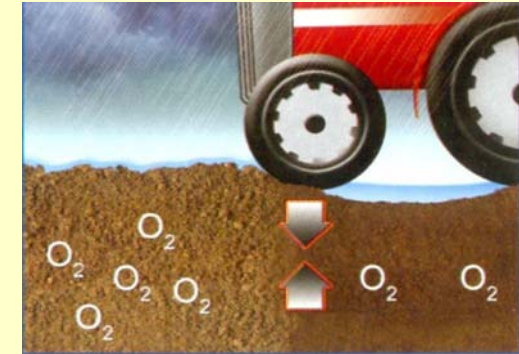


Making biochar



Function of organic fertilizer for soil improvement

- Improve soil structure and porosity
- Improves water holding capacity
- Source of plant nutrients and helps to keep nutrients available
- Increase CEC (exchange and sorption function)
and Stimulate microbial and enzymatic activities



Role of biofertilizer to improve soil productivity

Beneficial activities of biofertilizer:

N₂ fixing activity by transforming atmospheric N to ammonium form.

Increase plant nutrient availability of P, K through chelation, exchange reaction, production of organic acids promote plant growth by producing hormone to increase plant growth, speed up seed germination, improve seedling emergence, help the expansion of root system

Secrete antifungal compounds to suppress soil borne pathogens, reduce to use pesticide, enhance plant drought tolerance

Total amount of biomass residues in Thailand

Agro-industrial waste Agricultural waste
39.24 mil t/yr 44.77 mil t/yr

Type of Raw materials	Amount (mil t/yr)
Rice straw	25.45
Corn & Sorghum stalk	7.34
Legume residue	2.23
Sugar cane leaf	9.75
Bagasse	24.09
Sawdust	1.44
Rice husk	3.75
Corn cob	1.36
Cassava peel and cake	6.11
Oil palm empty fruit bunch	2.49
Total	84.01



Measure total amount of animal manure in Thailand

Type of manure	Amount (million ton/year)
Cattle	13.17
Pig	6.29
Poultry	7.48
Total	26.94



Properties of animal manure

Type of manure	Nutrient (%)			OC%	C/N
	N	P ₂ O ₅	K ₂ O		
bat manure (new)	9.31	4.42	1.42	.	.
bat manure (guano)	2.69	15.70	0.59	.	.
pig	2.41	3.38	1.31	25	11
goat	2.19	1.49	3.58	26	12
chicken	2.22	3.23	1.82	25	13
duck	1.09	2.74	0.46	.	.
buffalo	1.23	0.55	0.69	.	.
cow	1.39	1.03	1.75	21	15

Farmers can use farm manure substitute chemical fert.

Distribution successful innovation of LDD microbial products for increasing crop production

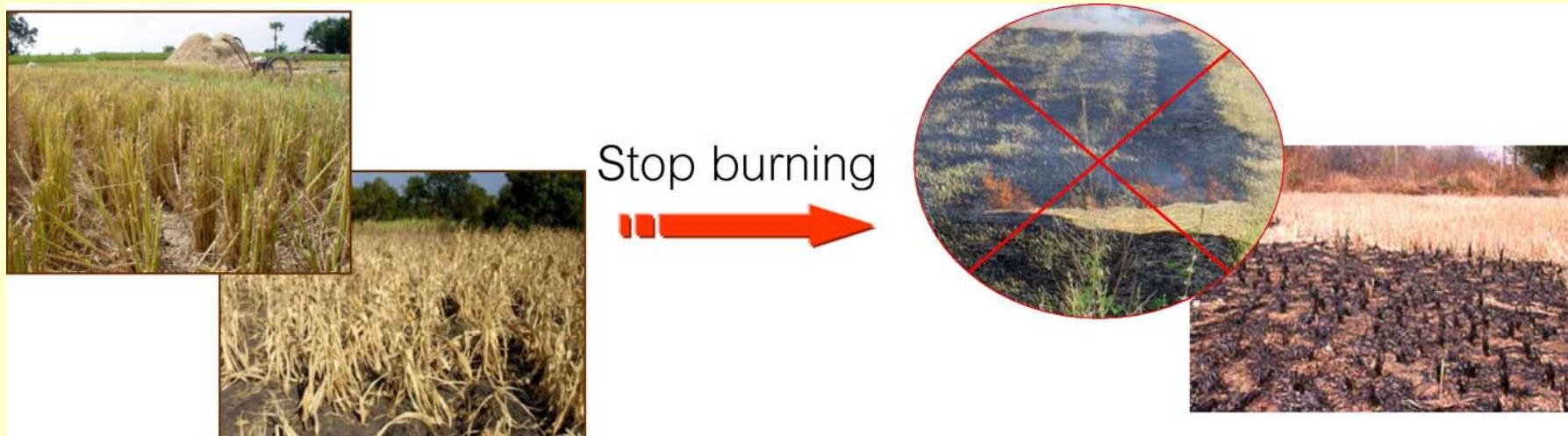
First group: to improve soil properties, increase soil fertility, produce plant hormone



Second group: to control plant diseases and insect pest



Encourage stop stubble burning

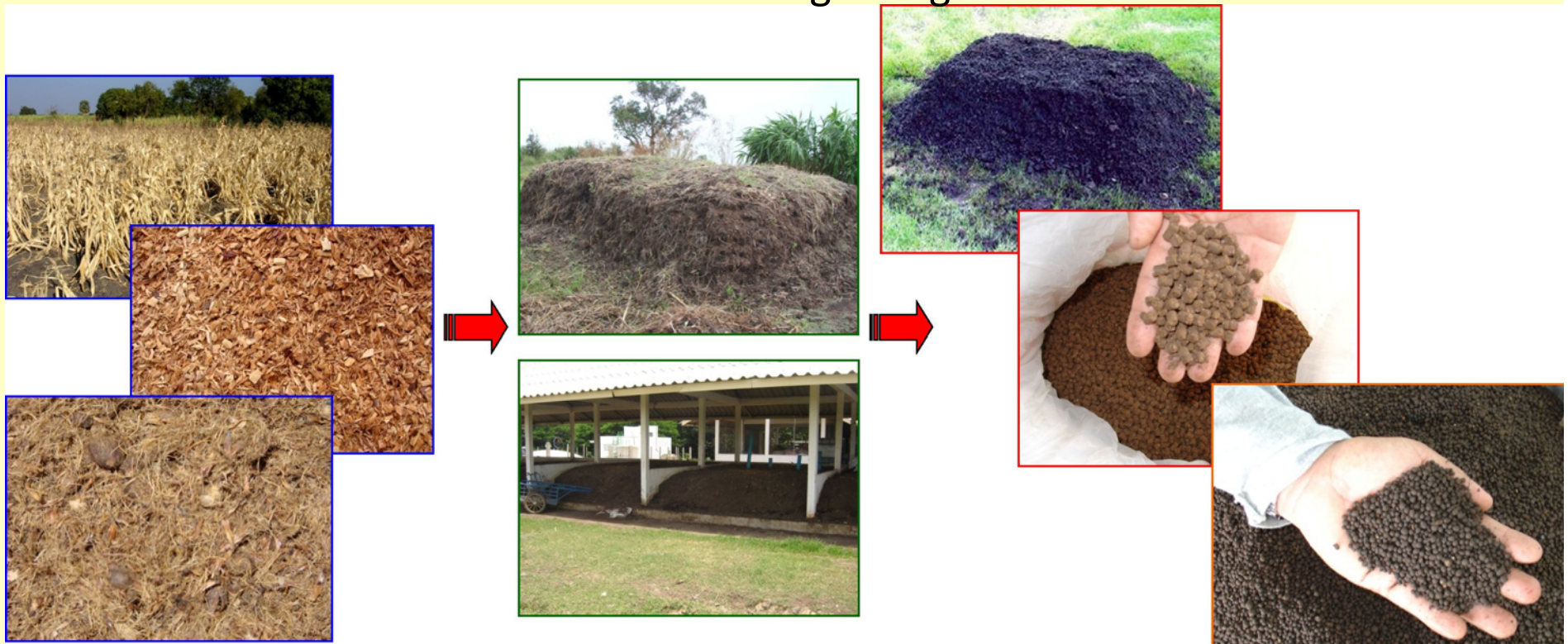


Losses of organic matter and soil nutrient •
Changed soil structure , Depleted beneficial
microorganisms, causes of air pollution &
GHG

Campaign zero open burning activity focus on incorporated stubble for
mitigate global warming and increasing soil organic matter

Using microbial activator Super LDD1 to encourage making compost

A group of high efficient microorganisms activate decomposing process of hardly decompose component (cellulose, lipid) to decrease composition time for making compost. This activator consisted of cellulolytic fungi and actinomycetes including lipid degrading bacteria.



Super LDD 1 : raw material proportion

Component of making compost fert. 1 ton

- plant residue (dry weight) 1,000 kg.
- animal manure 200 kg.
- urea 2 kg.
- Super LDD 1 1 package



Hardily residual material decompose within 3-4 months. Easily residual material decompose within 30-45 days

making compost fertilizer In devidual farm



- Residues from plants + farm manure

Producing bio-extract by using microbial activator Super LDD 2



A group of high efficient microorganisms activate fermentation and digestion process of fresh and succulent organic wastes such as residues from fruit, vegetable, fish, snail to produce liquid bio-extract that consisted of plant growth hormones, amino acid, humic acid, organic acid and minerals. Such bio-extract can promote seed germination, root tissue development, stem elongation, stimulate budding, flowering and fruit growth.



SuperLDD 2 : raw material to produce bio-extract from plants /animal residue

- Fruits and/or vegetables 40 kg.
(if using animal :fish,snail residue) 30 kg.
- Molasses or other sugar 10 kg.
- water 10 litres
- Super LDD 2 1 package



Utilization and application rate of bio-extract

- Dilute bio-extract with water 1:500-1:1,000
- Spray at leaf or stem every 10-30 days
 - Rice : Spray at 30, 50 and 60 days during growing stage
 - Field crop: spray every 10 days before flowering stage
 - Vegetable and flower: spray every 10 days
 - Fruit tree: spray every 1 month before flowering stage



utilization of biofertilizer on growth and yield of Casava in Nakhon Ratchasima



- Dilute bio-extract with water ratio 1:500
- Spray at 1 and 2 months
- Application rate 100 liters/rai



utilization on growth of Orchid in Nakhonpathom

- Dilute bio-extract with water ratio 1:500
- Spray every 2 weeks
- Application rate 100 liters/rai



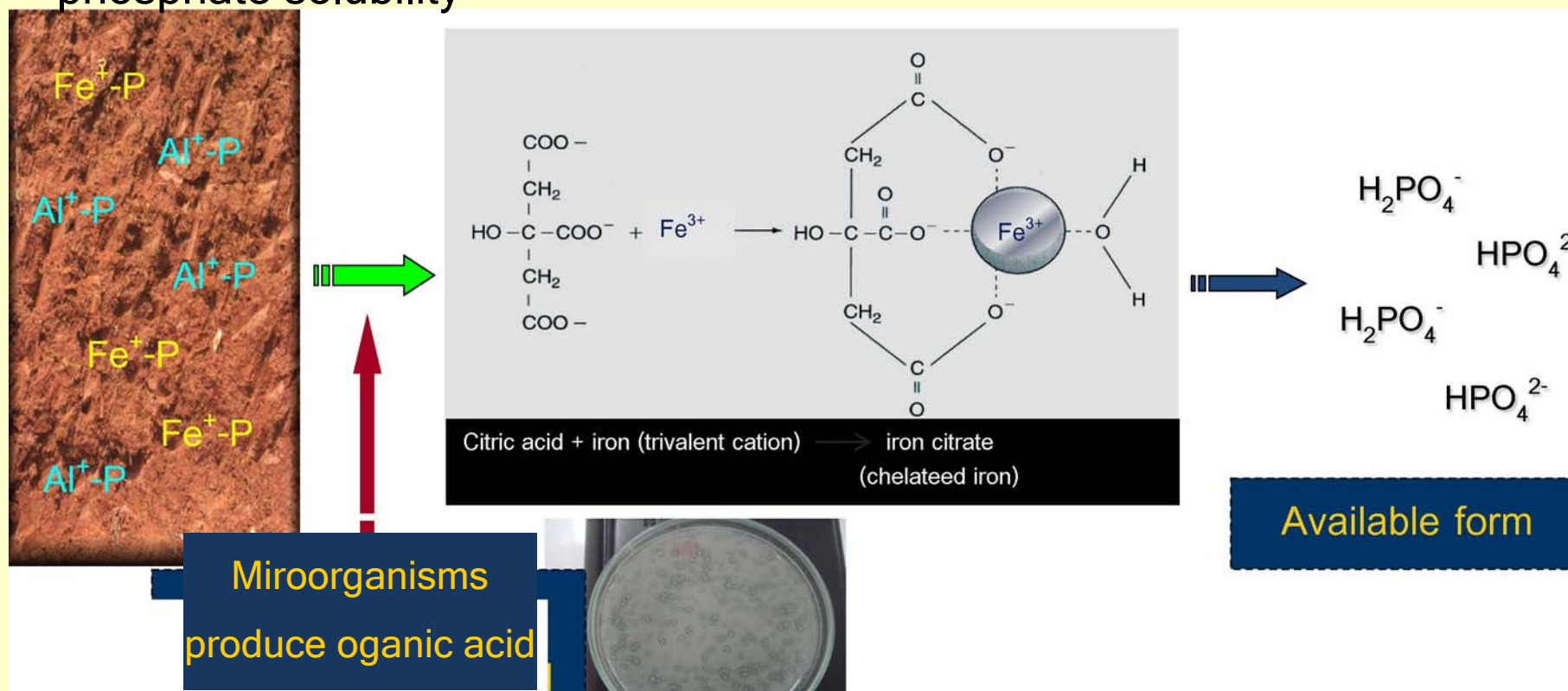
utilization of biofertilizer on yield and of super sweet corn and cabbage



Microbial activator Super LDD 9



This activator consisted of phosphate solubilizing microorganisms to release P particularly in acidic or acid sulfate soil ($\text{pH} < 4$) from unavailable form (inorg. phosphorus complex or phosphorus fixed by Fe Al) to available form for increase phosphate solubility



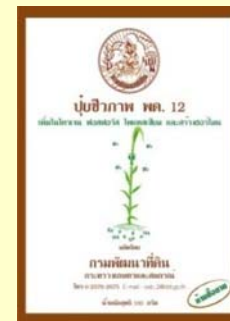
Raw material to LDD 9 cultivation

- Compost 500 kg.
- Molasses or other sugar 10 kg.
- Water 10 litres
- Super LDD 9 1 package



Bio-fertilizer LDD 12

A group of effective microorganisms can produce nutrient element or convert insoluble of inorganic compounds to soluble form to increase soil fertility especially N, P, K and produce plant growth hormone to enhance plant growth



Bio-fertilizer LDD 12

- Compost 300 kg.
- Rice bran 3 kg.
- Super LDD 9 1 package



- **Properties: Nitrogen** fixing bacteria. **Phosphate** solubilizing bac. **Potassium** solubilizing bac. And Plant growth promoting Rhizobacteria (**PGMB**)

Advantages of bio-fertilizer LDD12

Increase N content in soil 30-50 kg./ha/year

Increase P (rock phosphate soluble) 15-45%

Increase K-feldspar soluble 10%

Produce hormone stimulate root and plant growth

Reduce chemical fertilizer utilizing at least 25-30%

Increase plant yield 15%



Utilization and application rate of propagated LDD 12

Rice: 1.87 t/ha, broadcast throughout planting area

Field crop, vegetable: 1.87 t/ha, banding along the row of plant



Fruit tree: use the propagated 3-5 kg/ plant

**Applied on bottom of the hole for young plant and
around the circle of bush**



Green manure

Green manure is one kind of **organic fertilizer**. Legume crops usually are planted before cash crops two months and incorporated into soil to increase organic matter and plant nutrients especially, increase nitrogen content. Legume green manures are utilized in Thailand such as *Sesbania* sp., *Crotalaria* sp., *Canavalia* sp., *Vigna* sp. and *Cajanus* sp.



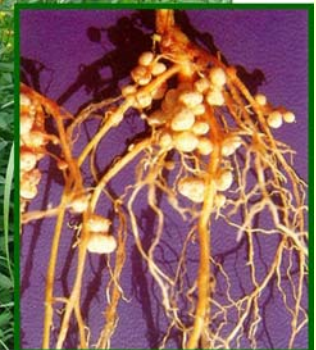
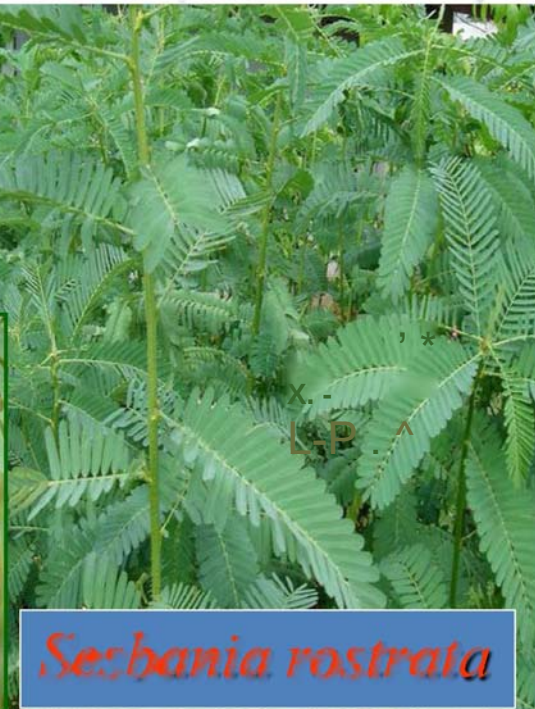
Nutrient content in green manure crops

Nutrient content (%)

Green manure	N	p	K	Ca	Mg	S
<i>Sesbania rostrata</i>	2.87	0.42	2.06	0.82	1.74	2.27
<i>Crotalaria juncea L.</i>	2.76	0.22	2.4	1.53	2.04	0.96
<i>Canavalia ensiformis L.</i>	2.72	0.54	2.14	1.19	1.59	0.77
<i>Vigna spp.</i>	2.68	0.39	2.46	0.87	1.59	0.48
<i>Cajanus cajan</i>	2.34	0.25	1.11	1.45	1.92	0.54

Microorganism LDD 11 promoting growth of green manure

- Symbiotic nitrogen fixing bacteria (*Rhizobium* sp.) specify to each kind of green manure.
- Promote growth and increase the biomass
 - *Sesbania rostrata* (lowland area, salt tolerant)
 - *Crotalaria juncea* (upland area, drought tolerant)



Constraints in biofertilizer technology

The biofertilizer technology is low cost, eco-friendly technology and several benefits of bio-inoculants.

However, It is quite not popular among the farming community. There may be several reasons such as

- 1) chemical fertilizers are more effective than biofertilizers,
- 2) biofertilizers are not used by fellow farmers in village,
- 3) low credibility of source for purchasing,
- 4) lack of motivation from extension agencies etc.

Thailand standard of biofertilizer

Ministry of Agriculture and Cooperatives issued the first standard of biofertilizer in 2007. Identity genus and quantity of microorganism must to declare in biofertilizer product. This standard consist of 6 kind of biofertilizer:

1. Rhizobium fertilizer
2. PGPR fertilizer
3. Blue green algae fertilizer
4. Arbuscular mycorrhiza fertilizer
5. Phosphate solubilizing fertilizer
6. Potassium solubilizing fertilizer



Transfer technology

To achieve less chemical used in agriculture for conservation of soil resource and environment

- Soil and Water Conservation**
- Soil Organic Matter**

To use of the products of LDD and appropriated technology for promotion and extension by Volunteer Soil Doctor to farmers

Volunteer Soil Doctors

They are farmers in the village and try to help LDD to solve soil problems.

Transferring new technology and LDD products to their neighbours and participating in LDD activities.

To conduct the demonstration plot of vetiver grass for soil and water conservation and soil organic matter improvement.



Training program

Intensive training VSD
Learning by doing
Net - work building
Materials distribution





Two training courses annually



Extension on biotechnology to substitute chemical agriculture substances

Objectives

-  **farmers understand the effective utilization of LDD products on biotechnology**
-  **Strengthening farmer groups and their alliances depend on the sufficiency economy philosophy by his Majesty the King (moderation, reasonableness and self immunity)**
-  **Develop farmer groups and their alliances to be organic agriculture groups**

Procedure

- Establishment the farmer groups about 17,000 groups in rural area in Thailand (farmers 50 persons/ group/village)
- Strengthening capacity building the farmers in perspective dimension of achievement innovation of biotechnology from LDD by training and demonstration
- Distribution successful innovation to farmers
- Follow up and evaluate the procedure farmers group and their alliances



Target/Outcomes

- Starting in 2007 until 2011 we have farmer groups about 17,000 groups
- From 2012 - 2015 develop farmer groups and their alliances to organic agriculture groups
- Average 500 farmers /year/800 ha (1.6 ha/farmer) are developed to organic agriculture system



Organic fertilizer and seed bank

- Farmer groups produce the compost and green manure seeds for other farmers
- Organic fertilizer bank distribute in every province and some provinces have seed bank



Vetiver grass for Soil rehabilitation



Vetiver grass is regarded as a miracle plant for land reclamation due to rapid growth, huge biomass, massive and long roots, that can penetrate vertically into soil and bind soil particles tightly to prevent soil erosion including maintain soil moisture content.

His Majesty the King of Thailand interested in vetiver grass and encourages government to utilize the beneficial matter of vetiver grass especially in soil and water conservation purpose, reclamation of infertile soil and environmental protection.



Vetiver grass has been applied widely in agriculture, soil and water conservation. It is one of the most effective and low cost natural methods of environmental protection and soil fertility improvement



Contour planting of vetiver across the slope to prevent soil erosion

Increase soil moisture

Overall Advantage

Producers :

- Reduce utilization of chemical fertilizer
- Increase crop yield and economic return
- Improve soil health and farm ecology
- Upgrade the quality of farmer's life



- chemical substances usage decreased 34.39 %
Saving budget 28,828 million bahts/year
- increasing yields 15.14 %
- Average farmers' incomes increase 29.21 %/family



Overall Advantage

Consumer:

- Food safety with less pesticide residues in products
- High nutrition food



Overall Advantage

Environment:

- Rehabilitation of degraded environments
- Reclamation bio-diversity for sustainable agriculture



**Thank you
for
your attention**

